



SUBSTRATE STABILITY: WHEN THE TROUBLES COME FROM THE BOTTOM

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INTRODUCTION

Substrate stability was a key limiting factor that controlled the heterogeneous distribution patterns of benthic metazoans across the Ediacaran-Cambrian transition. The so-called Agronomic Revolution (Seilacher and Pfluger, 1994) and Cambrian Substrate Revolution (Bottjer *et al.*, 2000) were linked to both diversification of burrowing metazoans and a switch from microbial mat-dominated to unconsolidated substrates. However, this “revolution” took place in a stepwise and progressive manner through Cambrian times due to the abiotic control on substrate replacement, mainly yielded by the availability of new kinds of substrates (Álvaro *et al.*, 2013).

TYPE OF SUBSTRATES

Soupgrounds (saturated in water and incompetent), firmgrounds (stable and nearly lithified) and hardgrounds (lithified) co-existed in the Cambrian although controlled by different factors, such as microbial and shelly carbonate production, and syngenetic or earliest-diagenetic precipitation of apatite, calcite or iron oxy-hydroxides. In the absence of microbial crusts, interaction of early diagenetic precipitation of calcite, apatite or hematite/goethite occluding primary porosity and sedimentation rate yielded new available substrates for colonization by spiculate and non-spiculate (archaeocyathan) sponges, chancelloriids and new echinoderm clades. Their palaeogeographic distribution exhibits a microbial mat/epifaunal antagonistic relationship between microbial-dominated reefs and crusts vs. mud-sticker sessile metazoans.

FINAL CONSIDERATIONS

Modification of shelly substrates (or shell pavements) through Cambrian times was related to thickness increase, shell content and composite development of hiatal surfaces, in some cases encrusted with microbial mats and biofilms. As a result, microbially induced precipitation of calcite on surfaces and occluding primary porosity available in shell-dominated sediments led to the progressive occurrence of firm-to-hardgrounds. Substrate stability was then not only yielded by scattered shells, but also by their earliest-diagenetic cementation (Zamora *et al.*, 2010). Several carbonate hardground substrates were then occurring: (i) microbial-dominated reefs, mats and biofilms exhibiting stromatoid and thromboid fabrics; (ii) microbially influenced shell accumulations with hiatal interbed surfaces marked by development of microbial crusts; (iii) shell substrates with no macroscopic evidence of microbial evidence but earliest-diagenetic precipitation of calcite cements occluding primary porosity; and (iv) biofilms forming microbially induced sedimentary

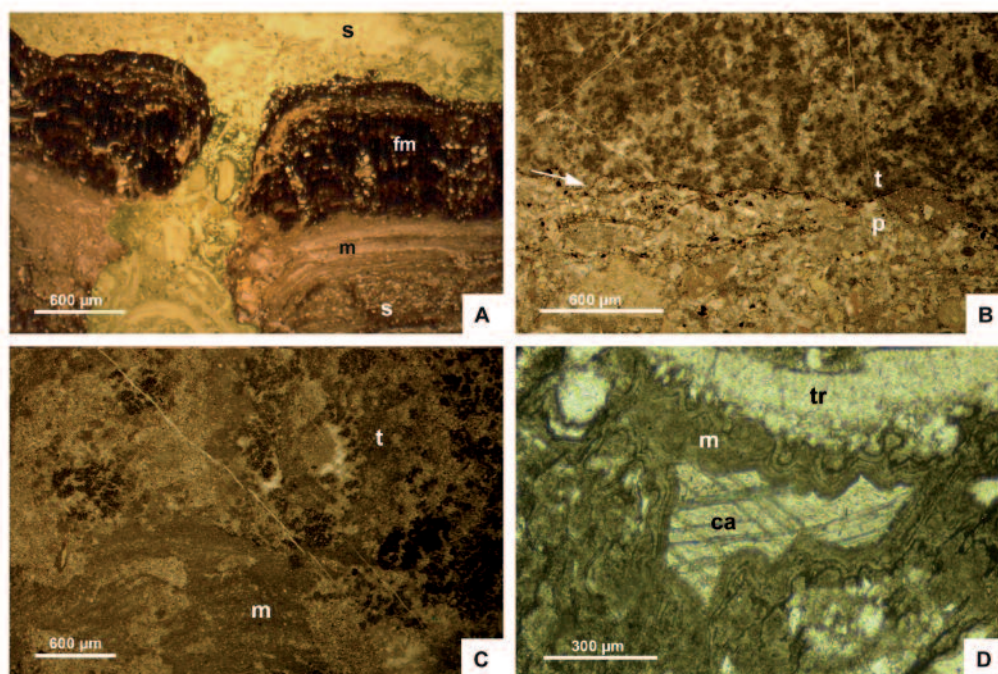


Figure 1. Thin-section photomicrographs of Cambrian carbonate and phosphate hardgrounds. A. Microbial laminae encrusting a shelly accumulation and eroded and partly infilled (false greenish colour) by overlying echinoderm-dominated packstone; Brèche à Micmacca Member, Anti-Atlas, Morocco. B. Pyroclastic substrate encrusted by thrombolitic crust (erosive contact arrowed); Lemdad Formation, High Atlas, Morocco. C. Stromatoid mat capped by thrombolitic crust; Lemdad Formation, High Atlas, Morocco. D. Interparticular porosity of a shelly pavement encrusted by phosphatized microbial mats and finally occluded with calcite; Talis Member (Marcory Formation), northern Montagne Noire, France. Abbreviations: ca. calcite, fm. ferruginized microstromatolitic mat, m. microstromatolitic mat, p. pyroclastic substrate, t. *Epiphyton*-dominated thrombolite, tr. trilobite sclerite.

structures (MISS) and yielding partial stability to clayey soupground substrates. These substrates played nucleation roles for colonization by the so-called chancelloriid-echinoderm-sponge (CES) community. The latter differed from: (i) the microbial-archaeocyathan (reefal) and microbially dominated, carbonate-hardground communities; and (ii) the (spiculate) sponge-thrombolite phosphate-hardground communities.

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